Space Weather Technical Forecast

Issued on Thursday, 22 December 2022 at 13:18 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of M-class flares and slight chance G1/Minor Geomagnetic Storms.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low, with occasional Common Class flares. AR3169 (Csi/Beta) produced the two largest flares during the period a C5 at 21/2102 UTC and a C7 at 21/2236 UTC. There are currently 7 sunspot regions on the front facing disc, AR3166 transited to the far side in the period to be replaced by a new region (Bxo/Beta) in the northeast. The largest regions on the disc are AR3163 (Dki/Beta) and AR3169 (Csi/Beta). AR3163 is now approaching the southwest limb and is becoming harder to analyse. Meanwhile AR3169 appears to have shown some decay with fading of some trailing spots and has been re-classified as Beta. AR3171, in the northeast, is also a region of note being in a Beta-Gamma formation. AR3168 also appears to now be in Beta-Gamma formation, with a couple of spots developing ahead of a mature spot, however this region looks to be more open and thus less complex. All other regions remain small and simple.
No Earth directed CMEs were observed in the available imagery during the period. A CME which left the northeast of the Sun early on the 21st December has be re-analysed and is now thought to miss to the east of Earth rather than causing a glancing blow.

Solar Wind / Geomagnetic Activity: The solar wind as measured by DSCOVR at L1 rose from ambient levels to become slightly elevated by 21/1425 UTC. It peaked at 434 km/s before gradually decreasing back to below 400 km/s. The density was generally average (5-10 ppcc) but was slightly above average at the start of the period. The total IMF, Bt, was initially Moderate (8-13 nT) but declined to weak levels (5-8 nT) from 21/1530 UTC. The Bz generally fluctuated weakly +5/-6nT, but a brief period (21/1430-1530 UTC) to -10nT occurred. The phi angle was initially negative (towards the Sun), but changed around 21/1430 UTC to become largely positive (away from the Sun). These solar wind parameters possibly suggest a weak CIR followed by a weak positive coronal hole fast wind influence. Resultant geomagnetic activity was Quiet to Unsettled (Kp 1-3).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) as measured at GOES16 remained at Background levels. High energy electron flux (greater than 2 MeV), as observed by GOES16, was at Background levels to occasionally Moderate levels, peaking at 131 pfu. The associated 24-hour fluence continued on a steady trend well below Active (1e8 integrated pfu). Observed fluence at 22/0001 UTC was 1.33e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is likely to remain Low, with occasional C class flares. There remains a consistent chance of M-flares and slight chance of an X-flare throughout the forecast period as departing spots are anticipated to be replaced by new regions from the far side.

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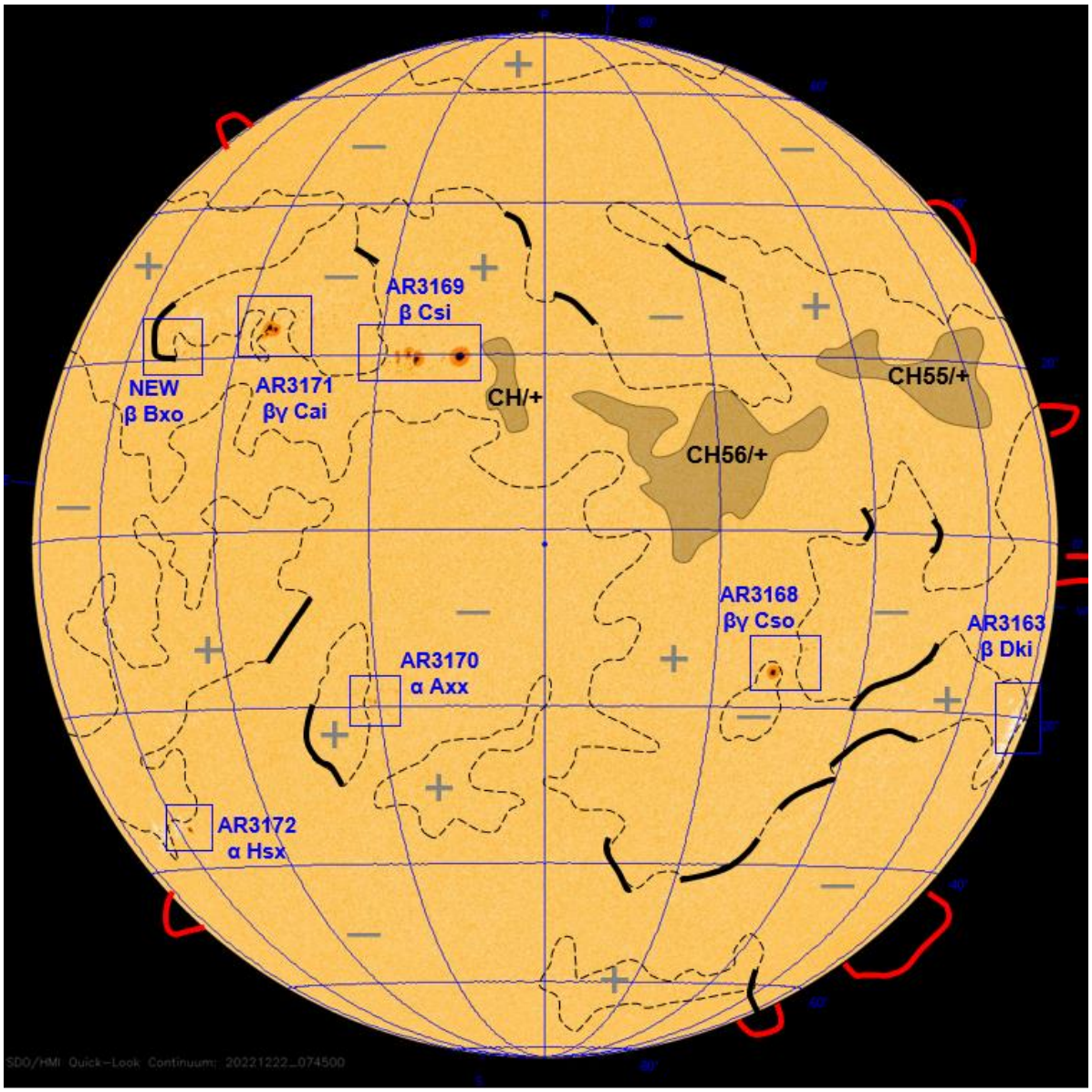
Solar Wind / Geomagnetic Activity: No CMEs currently feature in the forecast. Solar winds are forecast to be slightly elevated to elevated through the period due to the combination of High Speed Streams (HSS) from CH55/+ and then CH56/+. Quiet to Unsettled geomagnetic activity is most likely, with spells of Active. There is a slight chance of G1 Minor Storms throughout.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at Background levels throughout, although there is slight chance of this reaching the S1/Minor Storm level should any notable flares occur. High energy (greater than 2 MeV) electron flux as observed by GOES-16 is currently at background levels. An increase is possible later in the period due to expected fast winds from coronal hole features. The associated 24 hour electron fluence is forecast to remain below the Active (1e8 integrated pfu) threshold, despite the expected rising trend.

Figure 1. Solar Analysis Valid 22/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No CMEs currently feature in the forecast, however there have been numerous flares and peripheral CMEs recently and thus a transient event cannot be ruled out.

Solar winds are forecast to be predominantly slightly elevated, and occasionally elevated, through the period due to the combination of High Speed Streams (HSS) from CH55/+ and then CH56/+. This is in broad agreement with MOSWOC Enlil and the 27-day persistence model, and also with data from STEREO-A data.
Quiet to Unsettled geomagnetic activity is most likely, with spells of Active. There is a slight chance of G1 Minor storms throughout, most likely as Earth transitions to the high speed stream from CH56 later on day 2 into day 3 (23rd/24th).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	20	20	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

NIL

Figure 2: MOSWOC Solar Wind Persistence Model

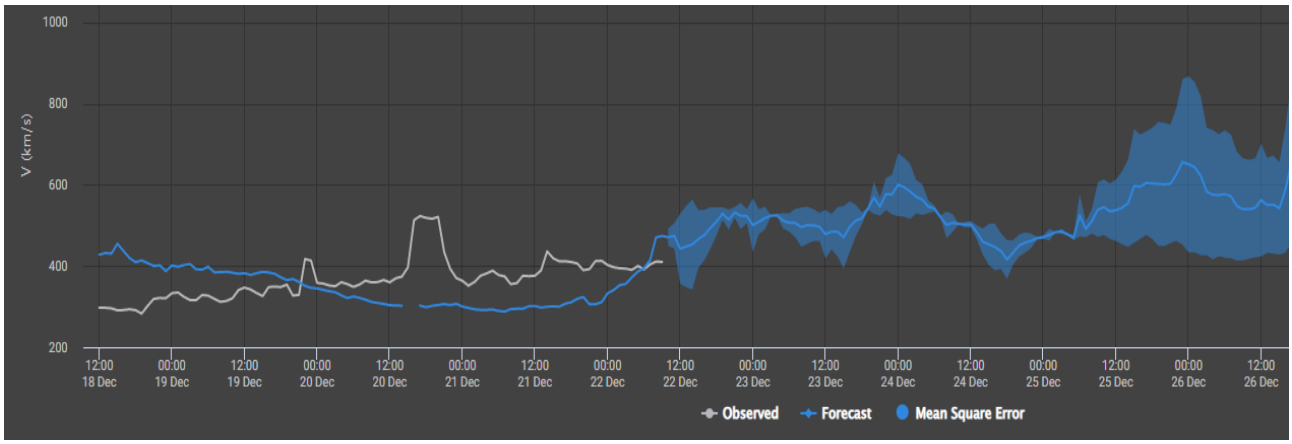

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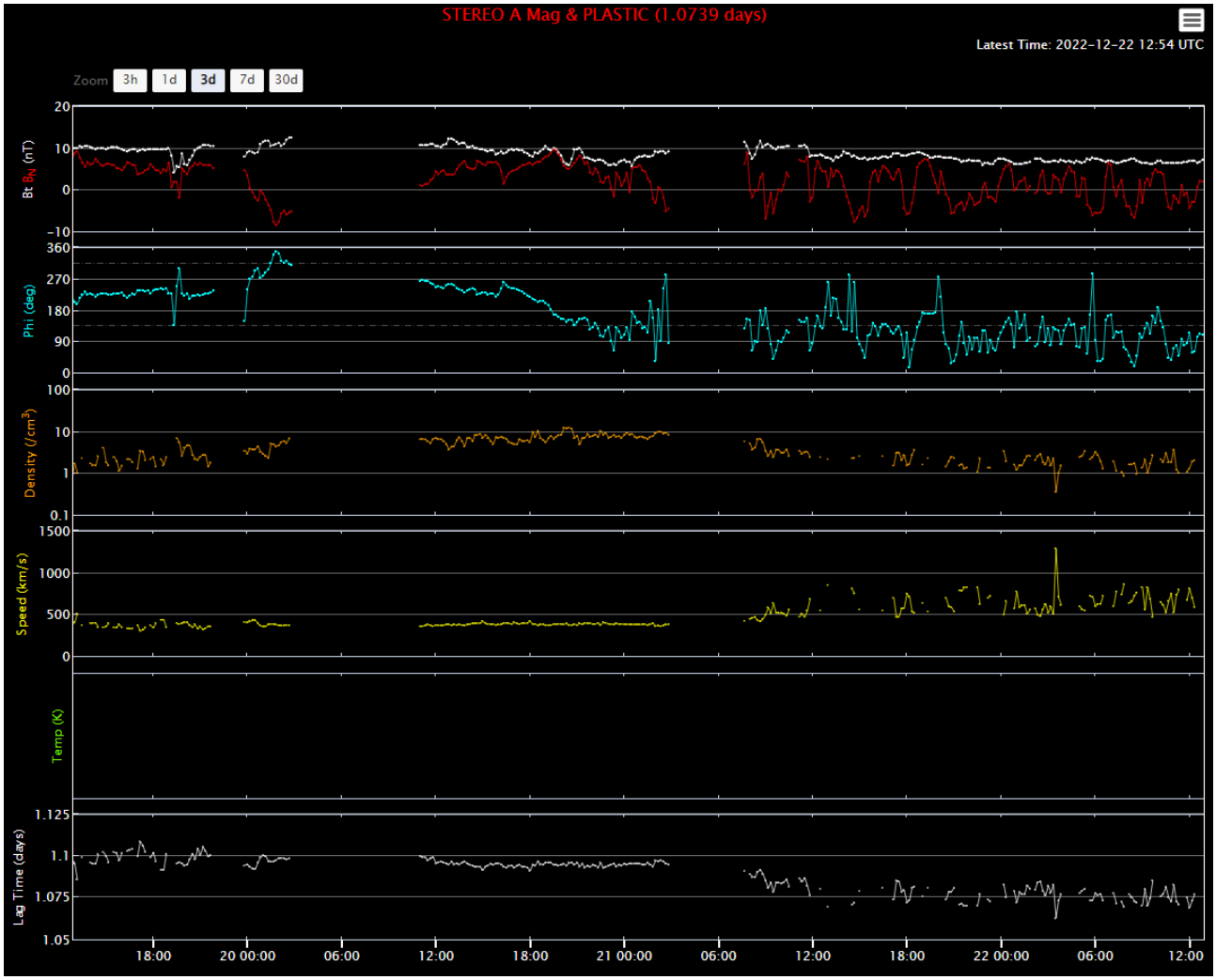
Figure 3: 3 day trace for solar wind parameters at STEREO A, which is roughly 1 day ahead of Earth with respect to the Parker Spiral


STEREO A Mag & PLASTIC (1.0739 days)
Latest Time: 2022-12-22 12:54 UTC
Zoom 3h 1d 3d 7d 30d
Bt Bn (nT)
Phi (deg)
Density (/cm3)
Speed (km/s)
Temp (K)
Lag Time (days)
18:00 20 00:00 06:00 12:00 18:00 21 00:00 06:00 12:00 18:00 22 00:00 06:00 12:00

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Radio Blackouts - X-Ray Flares:

Solar activity has been Low over the past 24 hours with occasional C-flares. There are currently 7 sunspots regions on the visible disc, with a new unnumbered region recently developing in the northeast. The largest regions on the disc remain AR3163 (Dki/Beta) near the southwest limb and AR3169 (Csi/Beta) in the northeast, which has been responsible for the majority of recent significant flare activity. AR3171, in the northeast, is also a region of note being in a beta-gamma formation. All other regions are generally smaller and simpler.
AR3163, which makes up a significant proportion of the current flare risk, will soon be transiting to the far side. However, this is likely to be replaced by a region round the northeast limb over the next 24-36 hours, which has been detected on far-side products and is now appearing on STEREO-EUVI imagery. A chance of M-class flares and slight chance of an X-flare is therefore kept consistent throughout.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	30	30	30	30
Very Active	R3 to R5 X Class	No	5	5	5	5

Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as observed by GOES-16 is expected to remain at background levels. However, there is a slight chance of an enhancement reaching the S1 Minor Storm level. Probabilities are slightly higher at the start of the period, with various spots recently transiting to the far side.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	10	10	5	5
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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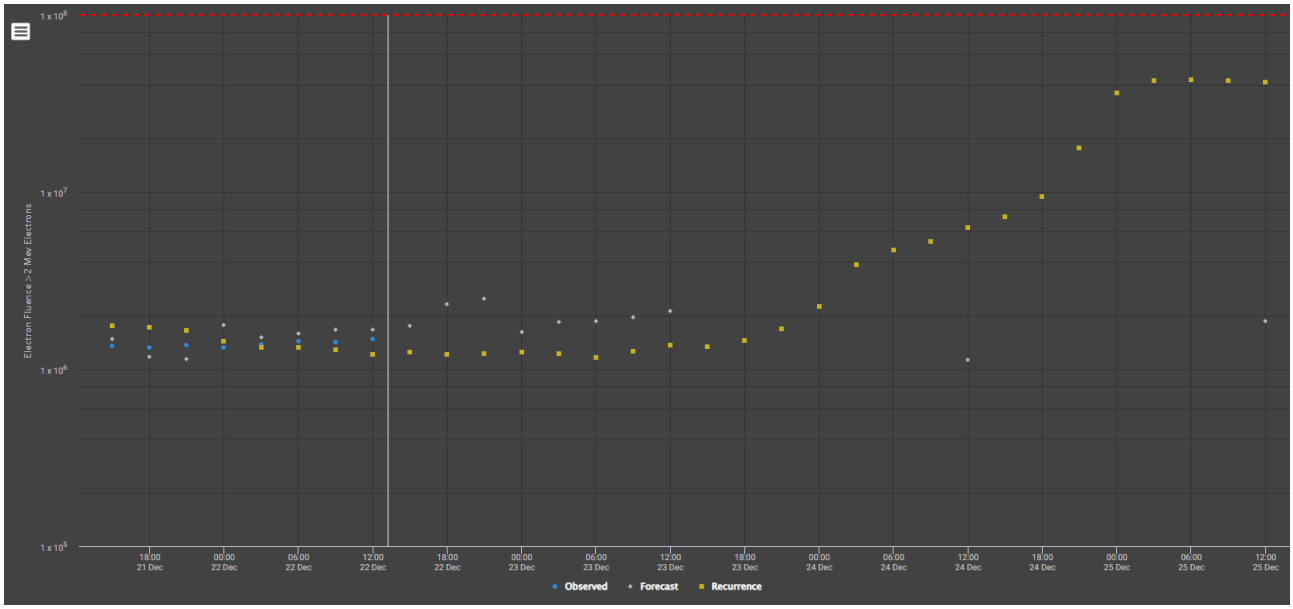
High Energy Electrons Event (≥ 2MeV):

High energy (greater than 2 MeV) electron flux as observed by GOES-16 is currently at background to occasionally moderate levels. Enhancements in the solar wind from coronal hole features through the period have the potential to result in increased counts later in the period, most likely rising to Moderate, with a chance of a diurnal peak of High on from day 3 (24th) but more likely on day 4 (25th).
The associated 24 hour electron fluence is forecast to remain below the Active (1e8 integrated pfu) threshold, despite a rising trend, as indicated by REFM, which is currently considered to be giving good guidance. On the previous rotation which was similar in terms of coronal holes, the fluence rose on the equivalent of day 3 (24th) but didn't quite reach Active for several more days. As such, fluence may rise later in the period, however this is low confidence and it is more likely fluence will stay below Active until next week.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	10	30
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: GOES-16 observed electron fluence, REFM data and recurrence, showing increase from day 3 (24th).



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